

PETROLIA DAM

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Manual for Operation and Maintenance

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**State Water Projects Bureau
Water Resources Division
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OVERVIEW

Petrolia Reservoir and Dam are located in Petroleum County approximately 7 miles southeast of the town of Winnett. (Figure 1) Petrolia Dam is located on Flatwillow Creek. (Figure 2) The Petrolia Water Users Association (herein called "association") operates the dam.

The construction of the earthfill dam and dike were completed in August 1951. Petrolia Dam is 59 feet high and 961 feet long, while the dike is 2,574 feet long. The dam's outlet works consist of: an approach channel; a concrete intake structure; a 60-inch diameter conduit; two wet well chambers (a control tower which contains the emergency and operating gates and an outlet for the highline canal, and a second wet-well chamber containing a vertical turbine pump and a control gate); delivery pipelines to the highline canal; concrete outlet structures (one at the highline canal outlet, one at the lowline canal outlet, and one at the return to Flatwillow Creek); a stilling basin; and a return channel to Flatwillow Creek.

The control tower contains a 60-inch by 60-inch rectangular slidegate (emergency valve), a 60-inch diameter slidegate (operating valve), and a 30-inch slidegate and outlet for the highline irrigation canal. The 30-inch gate is set on the north wall of the control tower. A gatehouse sits over the control tower and gate operators. All gate operators are located at the top of the tower. The maximum capacity of the outlet is 470 cubic feet per second (cfs).

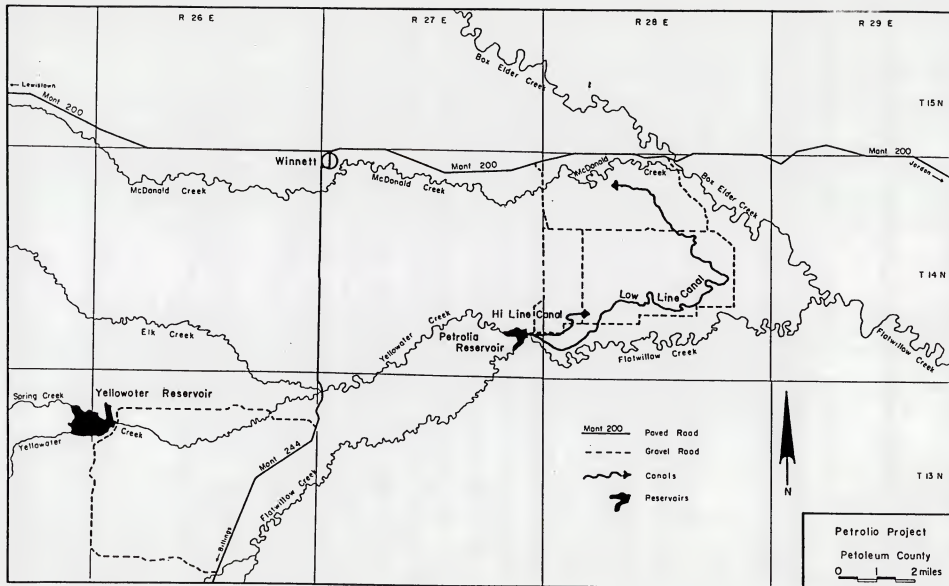


FIGURE 2. PROJECT AREA MAP

The lower gatehouse covers the second (lower) wet well with a 60-inch diameter slidegate, which controls the releases to the low line canal and the return flows into Flatwillow Creek.

The spillway is located in the right abutment through the earthen dike section of the dam. The spillway is a concrete lined chute with a gravel approach section and a concrete ogee crest. The approach channel is approximately trapezoidal in shape with a minimum base width of 100 feet. The side slopes are nearly vertical. The approach channel is constructed on approximately a horizontal grade, and transitions to the reservoir basin about 125 feet upstream of the spillway crest. Three concrete piers are located on 25-foot centers across the ogee crest. The piers originally supported a footbridge which has since been dismantled. Spillway width at the ogee crest and in the chute is 100 feet. Energy dissipation is provided by a flip bucket at the end of the chute, and a stilling basin constructed in rock. Spillway flows pass from the stilling basin into Johnson Coulee then on into Flatwillow Creek. The maximum capacity of the spillway is 10,200 cfs.

Water from the reservoir primarily is used for irrigation water supply. The reservoir also is used for water-based recreation.

STATISTICAL INFORMATION

1. General

- | | |
|-----------------------|---|
| a) Owner | Montana Department of
Natural Resources and
Conservation (DNRC) |
| b) Operator | Petrolia Water Users
Association |
| c) Location | Sections 25 and 36, Township
14 North, Range 27 East |
| d) Latitude | 46°56'24" |
| Longitude | 108°14'30" |
| e) County--State | Petroleum--Montana |
| f) Watershed Location | Flatwillow Creek-Musselshell
River, Missouri River basin |
| g) Drainage Area | 612 square miles |

2. Principal Elevations (feet above mean sea level)

- | | |
|----------------------|--------------|
| a) Maximum Dam Crest | 2,909.6 feet |
| b) Settled Dam Crest | 2,908.0 feet |
| c) Normal Full Pool | 2,898.6 feet |
| d) Spillway Crest | 2,898.6 feet |

3. Reservoir

- | | |
|--|--|
| a) Length of Maximum
Pool (approximate) | 2.2 miles |
| b) Maximum Reservoir
Level of Record | 2,900.6 feet, estimated (May
1964, June 1975 & March
1979) |
-
-

-
- | | |
|--------------------------------|-----------|
| c) Surface Area at Normal Pool | 515 acres |
|--------------------------------|-----------|

4. Storage

- | | |
|---|------------------|
| a) Maximum Storage (elevation 2,908.0 feet) | 14,000 acre-feet |
| b) Active Storage (elevation 2,898.6 feet) | 8,380 acre-feet |
| c) Maximum Surcharge | 5,620 acre-feet |

5. Hydrology

- | | |
|---------------------|--|
| Inflow Design Flood | 0.5 Probable Maximum Flood
(0.5PMF; 66,303 cfs peak flow) |
|---------------------|--|

6. Embankment (Dam)

- | | |
|--|-------------------------|
| a) Type | Earthfill |
| b) Hydraulic Height | 59 feet |
| c) Crest Length | 961 feet |
| d) Crest Width | Variable: 12 to 17 feet |
| e) Downstream Slope | 1v on 2.0h |
| f) Upstream Slope (above normal pool) | 1v on 2.0h |
| g) Upstream Slope (below normal pool elevation 2,898.6 to 2,888.6) | 1v on 2.5h |
| h) Upstream Slope (below elevation 2,888.6 feet) | 1v on 4.0h |
-

7. Embankment (Dike)

- | | |
|---------------------------------------|------------------------|
| a) Type | Earthfill |
| b) Hydraulic Height | 16 feet (Approx) |
| c) Crest Length | 2,574 feet |
| d) Crest Width | Variable 12 to 17 feet |
| e) Downstream Slope | 1v on 2.0h |
| f) Upstream Slope (above normal pool) | 1v on 2.0h |
| g) Upstream Slope (below normal pool) | 1v on 2.5h |

8. Spillway

- | | |
|-------------------------------|--------------|
| a) Control | None |
| b) Crest Elevation | 2,898.6 feet |
| c) Capacity
(Elev. 2908.0) | 10,200 cfs |

9. Outlet Works

- | | |
|------------|---|
| a) Size | One 60-inch and one 30-inch diameter reinforced concrete pipe |
| b) Length | 330 feet (60-inch) and 105 feet (30-inch) |
| c) Control | One 60-inch by 60-inch slide gate valve and two 60-inch diameter slidegate valves, and one 30-inch diameter slidegate valve with manual operators |
-
-

d)	Capacity at 2,908.0 feet Pool Elevation	470 cfs
e)	Design Invert Elevation	2,849.6 feet (60-inch conduit) 2,888.1 feet (30-inch conduit)
f)	Trashrack	Yes
g)	Highline Canal Capacity	20 cfs
h)	Lowline Canal Capacity	100 cfs

OPERATING PROCEDURES

The association manages Petrolia Reservoir to provide an adequate supply of irrigation water to meet contracts with water users without exceeding safe storage or flow levels.

Method and Schedule of Operation

The association's goal is to have the reservoir full before contract holders start putting in calls for water. The date that irrigation releases begin varies from year to year, with early May typically the earliest. Irrigation releases usually end by September 15, but occasionally continue on into October. The actual dates that releases begin and end depend on a year's climatological and hydrological conditions.

The maximum reservoir elevation is restricted to 2,892 feet (5,460 acre-feet), which will allow a 5-year rain storm to be safely routed through the reservoir and allow time to establish reservoir monitoring during a moderate to heavy rain.

The maximum reservoir elevation for winter storage is 2,887.0 feet with 3,712 acre-feet of storage. This winter maximum helps prevent damage to the riprap and embankment from wind-driven waves and ice. The minimum reservoir elevation for winter storage is 2,865.0 feet with 162 acre-feet of storage. This winter minimum helps prevent ice damage to the inlet structure for the outlet works.

Safe Drawdown

The stability of Petrolia Dam has been investigated, but a maximum safe drawdown rate was not established, so the DNRC recommends that drawdown rate not exceed one foot per day.

Limitations of Appurtenances

Appurtenances at Petrolia Reservoir include the delivery canals, the spillway and the outlet works. The maximum combined capacity of the delivery canals is 120 cfs, design capacity (100 cfs for the lowline canal and 20 cfs for the highline canal). At the minimum dam crest elevation, the outlet works' capacity is 470 cfs. If the outlet works are operated far in excess of the delivery canals' capacity, the canals and structures can be damaged, without passing the excess flow through the low level outlet which returns the flow to Flatwillow creek. The spillway capacity at elevation 2,908 feet is 10,200 cfs. Outlet and spillway rating tables are shown in Appendix A.

Dam Operator

The responsibility for the daily operation of the dam and reservoir rests with the association and its dam operator. The dam operator is generally authorized to operate the reservoir to meet the association's goal of providing contract water without exceeding safe storage and flow levels. The dam operator's specific responsibilities are to:

1. *Operate the mechanical features of the outlet works*
 2. *Coordinate filling of the reservoir and the release of water*
-
-

-
3. *Notify the State Water Projects Bureau (SWPB) of unusual occurrences such as impending floods, or excessive seepage.*
 4. *Perform certain maintenance tasks*
 5. *Monitor weather conditions*
 6. *Monitor seepage*

Typically, the out-going dam operator and the association train a new dam operator. The dam operator's training focuses on the mechanical operation of the gates, measurement of the storage level, measurement of the rate of water release, and record keeping. The outlet gates are manually operated with a hand crank. The outlet works are intended to be used for controlling the release of irrigation water and not for providing emergency relief. The outlet works are, however, operated to keep the spillway from being used and to provide for some flood storage.

The dam operator is normally available daily to observe the dam and perform operating functions daily the filling and irrigation seasons, and is available weekly or monthly at other times of the year. While communication among the dam operator, the association, and the SWPB usually takes place by telephone, radio communication may be established during emergencies or unusual occurrences so the dam operator can speak directly with county authorities and communicate indirectly with the SWPB (see *Petrolia Dam Emergency Plan*).

Weather Monitoring

The dam operator, Lewistown Regional Office, water users and local weather observers monitor weather conditions through, local weather forecasts, the National Weather Service, and a number of rain gages and stream gages. A flood warning is issued when the local area receives 0.6 inches or more of precipitation. The warning notifies local authorities and residents to be on the alert.

Interaction with Other Dams

There are no dams located below Petrolia except for Fort Peck Dam. The safety of this dam is not affected by the operation of Petrolia Reservoir during either normal or emergency operations. Yellowstone Reservoir is the only large storage facility upstream of Petrolia Dam. Interaction with this dam is not generally a concern of the normal operation of Petrolia Dam. The amount of water that can be released by Yellowstone Reservoir can be easily handled by Petrolia. If it appears that the dam or dike at Petrolia will breach, the dam operator should notify the operator at Fort Peck Dam (406-526-3411).

INSPECTION AND MONITORING

The SWPB will inspect the dam annually. Appendix B includes an example of a SWPB inspection checklist. In addition to annual inspections, SWPB personnel will inspect the dam and reservoir during and after heavy runoff, after severe rainstorms and windstorms, during high storage periods, and after an earthquake. The embankment is monitored by instrumentation.

Structural Features Inspection

Structural features include the gatehouse, spillway, and outlet works (Figure 3). The SWPB will inspect these structures annually as part of its inspection program. Items to be checked or noted include, but are not limited to:

1. *Outlet Works*
 - a) Any differential settlement or movement resulting in cracking of the conduit
 - b) Erosion of the seals or concrete by cavitation immediately downstream of the gates
 - c) Major seepage of water into the conduit
 - d) Major deterioration of exposed concrete due to freeze/thaw cycles or sulfate reactions
 - e) Operation of all gates through a full cycle
 - f) Free, unobstructed operation of the air vent
 - g) Corrosion of any metal
 - h) Proper lubrication of the pedestals
-
-

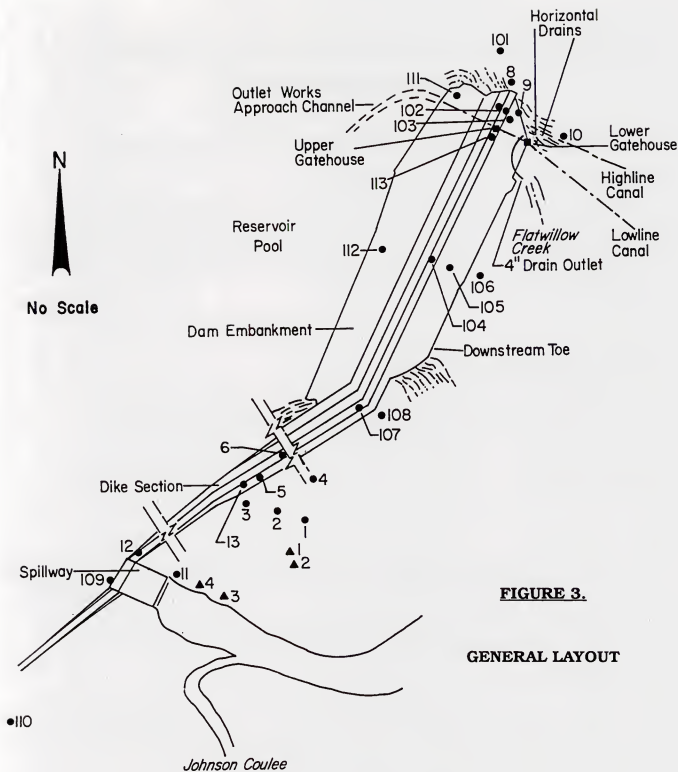


FIGURE 3.

GENERAL LAYOUT

LEGEND

- Monitoring Well Location
- ▲ Erosion Monitoring Pin Location

-
2. *Gatehouse* -- Any damage or vandalism
 3. *Spillway*
 - a) Cracking or movement of concrete
 - b) Absence of support material under the floor and under the flip bucket
 - c) Deterioration of concrete
 - d) Separation or movement of joints
 - e) Blockage of the approach or exit channel

Riprap Inspection

The riprap along the faces of the dam and dike should be at least 30 inches thick. Immediately after the occurrence of high water, the riprap will be inspected and additional riprap added if needed.

Instrumentation

Twenty-six groundwater monitoring wells and two horizontal drains have been installed in Petrolia Dam and the dam abutments. Their locations are shown on Figure 3. There are also four surface measurement reference pins. A brief description of the monitoring wells is shown on the following page.

Monthly readings of the monitoring wells and the drains are made by the Lewistown Regional Office (DNRC Water Resources Division), and the data forwarded to the SWPB in Helena.

TABLE 1**MONITORING WELL LOCATIONS**

<u>Well No.</u>	<u>Depth</u>	<u>Well Location</u>
1	20.0	Downstream slope - dike section
2	28.6	Downstream slope - dike section
3	38.6	Downstream slope - dike section
4	16.2	Downstream slope - dike section
5	24.2	Downstream slope - dike section
6	31.0	Downstream slope - dike section
7a,b	53.5/40.6	Dam crest - left abutment
8a,b	22.5/59.0	Left abutment
9a,b	49.0/26.7	Downstream slope of the dam - left abutment
10a,b	48.5/12.2	Highline canal embankment
11a,b,c	43.5/25.5/19.1	Left abutment above the spillway
12a,b	31.5/48.8	Left abutment above the spillway
13a,b,c	50.0/42.5/31.0	Dam crest - dike section
101	80.0	Left abutment
102a,b	75.0/50.0	Dam crest - left abutment
103	58.5	Downstream face of the dam - left abutment
104a,b	88.5/46.9	Dam crest near center of the dam
105a,b	75.0/32.0	Downstream face of the dam near center
106a,b	60.0/19.0	Downstream toe of the dam near center
107a,b	44.0/80.0	Dam crest near right abutment
108	59.0	Toe of the dam in right abutment
109	40.0	Spillway approach channel
110	30.0	Right abutment - south of spillway
111	60.0	Upstream face of dam - left abutment
112	60.0	Upstream face of dam near center
113	73.5	Dam crest near gatehouse

The location of the monitoring wells are shown on Figure 3.

Seepage Monitoring

Minor seepage has been observed at the left abutment contact between the highline canal and the lower gatehouse at the lowline canal level. Two horizontal drain pipes have been installed in this area. A four-inch drain pipe has been installed in the area of the lower gatehouse. Discharge from the pipes is monitored and measured monthly. This area is monitored monthly for embankment slides and sloughing.

Considerable seepage was identified on a steep slope located approximately 300 feet downstream from the bend in the dam embankment section. The seepage surfaces on an open, steep cliff which is 40 to 50 feet high. It is expected that the majority of this water originates in the reservoir pool and seeps along laminations in the sandstone. A smaller amount of seepage water travels through the shale bedrock. This is monitored by observation annually.

A small boil was identified in the Johnson Coulee stream bottom located about 300 feet from the dam embankment and below the cliff. This boil has not been located since its first discovery. The area is inspected during the annual SWPB inspections for changes.

At the intersection of the dam and right abutment, a small seepage area has been observed when the pool level is high. This is monitored by observation annually.

In the past, seepage has been observed emerging at the sandstone exposure below the dike section and about 300 feet south of the dam's right abutment. This, also is monitored by observation annually.

Seepage also occurs along the left slope below the spillway and under the flip bucket. These areas are monitored by observation monthly.

Except for the area below the spillway and the area with the drain pipes at the left abutment, these seepage areas should be monitored annually.

MAINTENANCE

The association is responsible for the project's routine maintenance. During regular visits, the dam operator will identify and perform normal maintenance activities. During annual inspections, the SWPB will also identify items that need maintenance or repair. The SWPB may supervise major repairs.

Routine Maintenance

As soon as a need is identified, the dam operator will perform any routine maintenance necessary to protect the dam or keep it in good working order. The dam operator will watch for any potential maintenance requirements during normal visits to the dam. Items that may occasionally need attention include, but are not limited to:

1. *Lubrication of gate-operating mechanisms.*
 2. *Debris or silt plugging the spillway or the outlet channel.* Accumulated debris that could affect the operation of these appurtenances will be removed at once, with all debris removed at least annually.
 3. *Erosion gullies on embankment.* Development of erosion gullies will be checked immediately. Gullies will be filled, compacted, and seeded. Particular attention will be paid to the abutment contact areas and the downstream face where four-wheel-drive tracks may become a problem.
 4. *Rodent damage.* Rodent burrows will be filled immediately and the rodents destroyed.
 5. *Upstream slope riprap.* Reservoir riprap normally will be maintained annually, but may occasionally need repairs because of high water or wave action.
-
-

-
6. *Vegetative cover on downstream slopes.* Good vegetative cover will be maintained, but large brush will be removed.
 7. *Noxious weeds on and around the dam.* The weeds will be sprayed at least once each year.

Annual Maintenance

The SWPB will conduct annual inspections of Petrolia Dam and Reservoir. During these inspections, any items requiring maintenance will be identified and recorded. Items needing annual maintenance include the spillway, outlet works, gates, riprap, roads, and gatehouse. Any other routine items needing immediate attention will also be noted.

After the association receives the SWPB inspection report, it will develop a maintenance schedule for performing identified tasks. While the dam operator or association members may perform the routine tasks, major repairs are more likely to be handled by a contractor. The SWPB may assist in contracting for repairs and may supervise the repair work.

Record Keeping

The SWPB will maintain records--including photographs--of all inspections and maintenance requirements. These records will also include flow measurements and storage volumes. Anyone who wants to review these records may do so in the SWPB's office at the Department of Natural Resources and Conservation in Helena, Montana.

The dam operator will keep records of the reservoir elevation, seepage observations or measurements, and any unusual conditions. These records may be reviewed at the dam operator's house.

REFERENCES

HKM Associates. December 1980. *Phase 1 Inspection Report, National Dam Safety Program; Petrolia Dam; Winnett, Montana; Petroleum County; MT-8*. Prepared for the State of Montana (DNRC) under the U.S. Army Corps of Engineers National Dam Safety Program.

Meserve, Bill, Petrolia dam operator. April 1994. Personal telephone and meeting communications with Sterling Sundheim, regional office Civil Engineering Specialist, Montana DNRC, Water Resources Division, Lewistown.

APPENDIX A

RATING CURVES AND TABLES

TABLE A-1**PETROLIA DAM****ACTIVE STORAGE IN ACRE-FEET**

<u>ELEV.</u>	<u>0.0</u>	<u>0.1</u>	<u>0.2</u>	<u>0.3</u>	<u>0.4</u>	<u>0.5</u>	<u>0.6</u>	<u>0.7</u>	<u>0.8</u>	<u>0.9</u>
2,855	0	0	1	1	2	3	3	4	4	5
2,856	6	6	7	7	8	9	9	10	10	11
2,857	12	12	13	13	14	15	15	16	17	17
2,858	18	18	19	20	20	21	21	22	23	23
2,859	24	25	25	26	26	27	28	28	29	29
2,860	30	33	35	38	41	43	46	49	51	54
2,861	56	59	62	64	67	70	72	75	78	80
2,862	83	86	88	91	93	96	99	101	104	107
2,863	109	112	115	117	120	122	125	128	130	133
2,864	136	138	141	144	146	149	152	154	157	159
2,865	162	168	174	180	186	192	198	203	209	215
2,866	221	227	233	239	245	251	257	262	268	274
2,867	280	286	292	298	304	310	316	321	327	333
2,868	339	345	351	357	363	369	375	380	386	392
2,869	398	404	410	416	422	428	434	439	445	451
2,870	457	468	478	489	500	510	521	531	542	553
2,871	563	574	584	596	606	616	627	637	648	659
2,872	669	680	690	701	712	722	733	743	754	765
2,873	775	786	796	807	818	828	839	849	860	871
2,874	881	892	902	913	924	934	945	955	966	977
2,875	987	1,000	1,015	1,030	1,045	1,060	1,075	1,090	1,105	1,120
2,876	1,135	1,150	1,165	1,180	1,195	1,210	1,225	1,240	1,255	1,270
2,877	1,285	1,300	1,315	1,330	1,345	1,360	1,375	1,390	1,405	1,420
2,878	1,439	1,458	1,477	1,496	1,515	1,534	1,553	1,572	1,591	1,610
2,879	1,629	1,648	1,667	1,686	1,705	1,724	1,743	1,762	1,781	1,800
2,880	1,825	1,850	1,875	1,900	1,925	1,950	1,975	2,000	2,025	2,050
2,881	2,075	2,100	2,125	2,150	2,175	2,200	2,225	2,250	2,275	2,300
2,882	2,325	2,350	2,375	2,400	2,425	2,450	2,475	2,500	2,525	2,550
2,883	2,575	2,600	2,625	2,650	2,675	2,700	2,725	2,750	2,775	2,800
2,884	2,825	2,850	2,875	2,900	2,925	2,950	2,975	3,000	3,025	3,050
2,885	3,082	3,113	3,145	3,176	3,208	3,239	3,271	3,302	3,334	3,365
2,886	3,397	3,428	3,460	3,491	3,523	3,554	3,586	3,617	3,649	3,680
2,887	3,712	3,743	3,775	3,806	3,838	3,869	3,901	3,932	3,964	3,995
2,888	4,027	4,058	4,090	4,121	4,153	4,184	4,216	4,247	4,279	4,310
2,889	4,342	4,374	4,406	4,438	4,470	4,502	4,534	4,566	4,598	4,630

TABLE A-1 *continued*

<u>ELEV.</u>	<u>0.0</u>	<u>0.1</u>	<u>0.2</u>	<u>0.3</u>	<u>0.4</u>	<u>0.5</u>	<u>0.6</u>	<u>0.7</u>	<u>0.8</u>	<u>0.9</u>
2,890	4,660	4,700	4,740	4,780	4,820	4,860	4,900	4,940	4,980	5,020
2,891	5,060	5,100	5,140	5,180	5,220	5,260	5,300	5,340	5,380	5,420
2,892	5,460	5,500	5,540	5,580	5,620	5,660	5,700	5,740	5,780	5,820
2,893	5,860	5,900	5,940	5,980	6,020	6,060	6,100	6,140	6,180	6,220
2,894	6,260	6,300	6,340	6,380	6,420	6,460	6,500	6,540	6,580	6,620
2,895	6,667	6,714	6,761	6,808	6,855	6,902	6,949	6,996	7,043	7,090
2,896	7,138	7,186	7,234	7,282	7,330	7,378	7,426	7,474	7,522	7,570
2,897	7,618	7,666	7,714	7,762	7,810	7,858	7,906	7,954	8,002	8,050
2,898	8,097	8,144	8,191	8,239	8,286	8,333	8,380	8,433	8,487	8,540
2,899	8,593	8,646	8,699	8,752	8,805	8,858	8,911	8,964	9,017	9,070
2,900	9,127	9,184	9,241	9,298	9,355	9,412	9,469	9,526	9,583	9,640
2,901	9,697	9,754	9,811	9,868	9,925	9,982	10,039	10,096	10,153	10,210
2,902	10,267	10,324	10,381	10,438	10,495	10,552	10,609	10,666	10,723	10,780
2,903	10,838	10,895	10,953	11,010	11,068	11,125	11,183	11,240	11,298	11,355
2,904	11,413	11,470	11,528	11,585	11,643	11,700	11,758	11,815	11,873	11,930
2,905	11,990	12,050	12,110	12,170	12,230	12,290	12,350	12,410	12,470	12,530
2,906	12,598	12,665	12,733	12,800	12,868	12,935	13,003	13,070	13,138	13,205
2,907	13,275	13,344	13,414	13,483	13,553	13,622	13,692	13,761	13,831	13,900
2,908	13,970	14,040	14,110	14,180	14,250	14,320	14,390	14,460	14,530	14,600
2,909										14,670

Top of tower grillage elevation 2,908.6

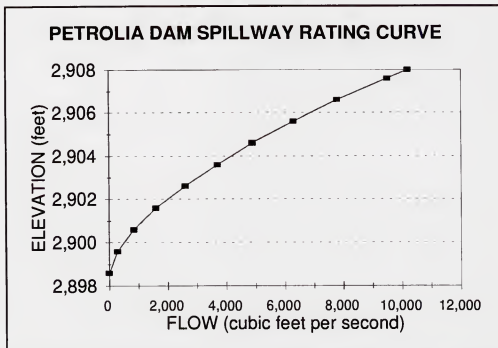
Concrete spillway crest elevation 2,898.6

TABLE A-2

PETROLIA DAM SPILLWAY RATING TABLE

Elevation <i>(feet)</i>	Flow <i>(cfs)</i>
2,898.6	0
2,899.6	290
2,900.6	840
2,901.6	1,600
2,902.6	2,600
2,903.6	3,700
2,804.6	4,900
2,905.6	6,300
2,906.6	7,800
2,907.6	9,500
2,908.0	10,200
2,908.6	11,300

FIGURE A-1



APPENDIX B

INSPECTION CHECKLIST

DEPARTMENT OF NATURAL RESOURCES AND CONSERVATION
DAM SAFETY INSPECTION REPORT

NAME OF DAM _____
DATE INSPECTED _____

INVENTORY NO. _____
HAZARD CATEGORY _____
TYPE OF DAM _____
YEAR BUILT _____

OWNER _____
OPERATOR _____
STREAM _____
DRAINAGE AREA _____

Reservoir Storage Status

	Water Surface Elevation (feet)	Storage (acre-feet)
At time of inspection	_____	_____
At spillway crest	_____	_____
At min. dam crest elevation	_____	_____
Flashboard crest elevation	_____	_____

ITEM	YES	NO	REMARKS	*ICC
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1. EMBANKMENT

A. Crest -- Height= _____ Length= _____ Width= _____

(1) Any visual settlements?				3
(2) Any misalignments?				4
(3) Any cracking?				1
(4) Any traffic damage?				5
(5) Other?				7

NOTE: *ICC stands for "Inventory Comment Code" which is found on the Inventory of Montana Dams. This comment code is for use by the Dam Safety Section.

ITEM	YES	NO	REMARKS	*ICC
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1. EMBANKMENT (continued)

B. Upstream Face -- Slope=

(1) Any erosion?				19
(2) Any longitudinal cracks?				9
(3) Any transverse cracks?				9
(4) Is riprap protection adequate?				10
(5) Any stone deterioration?				10
(6) Any visual settlement, slumps, sloughing, depressions or bulges?				9
(7) Adequate grass cover?				14
(8) Debris on the dam face?				15
(9) Other?				16

C. Downstream Face--Slope=

(1) Any erosion?				22
(2) Any longitudinal cracks?				19
(3) Any transverse cracks?				19
(4) Any visual settlement, sloughing, slumps, depressions or bulges?				19
(5) Is the toe drain dry?				31
(6) Are the relief wells flowing?				31
(7) Any boils at the toe?				19
(8) Any seepage areas?				17, 18
(9) Any traffic or animal damage?				22
(10) Any burrowing animals?				21
(11) Adequate grass cover?				24
(12) Other?				25

D. Amount and Type of Vegetation on the Dam

	14, 24
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ITEM	YES	NO	REMARKS	*ICC
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2. ABUTMENT CONTACTS

(A) Any erosion?				12, 20
(B) Any visual differential movement?				12, 20
(C) Any cracks?				12, 20
(D) Any seepage present?				36
(E) Other?				16, 25

3. OUTLET WORKS

A. Intake Structure -- Size=

(1) Any settlement?				70
(2) Any tilting?				70
(3) Do concrete surfaces show:				
a. Spalling?				70
b. Cracking?				70
c. Erosion?				70
d. Exposed reinforcement?				70
(4) Do joints show:				
a. Displacement or offset?				70
b. Loss of joint material?				70
c. Leakage?				70
(5) Metal appurtenances:				
a. Any corrosion present?				70
b. Any breakage present?				70
(6) Trash rack?				71
a. Condition?				71
b. Anchor system secure?				71
(7) Other?				71

ITEM	YES	NO	REMARKS	*ICC
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3. OUTLET WORKS (continued)

B. Conduit -- Type = _____ Size = _____

(1) Do concrete surfaces show:				
a. Spalling?				76
b. Cracking?				76
c. Erosion?				76
d. Exposed reinforcement?				76
(2) Do joints show:				
a. Displacement or offset?				76
b. Loss of joint material?				76
c. Leakage?				76
(3) Is the conduit metal?				76
a. Any corrosion present?				76
b. Protective coatings adequate?				76
(4) Is the conduit misaligned?				76
(5) Any calcium deposits?				76
(6) Other?				76

C. Gates and Tower

(1) Gates:				73, 74
a. Size: Operating:			Emergency:	
b. Type: Operating:			Emergency:	
(2) Controls operational?				76
(3) Controls lubricated?				76
(4) Operational problems?				75
(5) Leakage around gates?				73, 74
(6) Condition of gate seals?				73, 74
(7) Any cavitation damage? so, describe?	If			73, 74
(8) Describe air vent-size and condition.				73, 74

ITEM	YES	NO	REMARKS	ICC
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3. OUTLET WORKS

C. Gates and Tower (continued)

(9) Is there a jet pump?				82
a. Is it operational?				82
b. Leakage?				62
(10) Is the tower dry? wet?				77
(11) Any seepage in the tower?				77
(12) Condition of the tower?				77
(13) Any safety problems?				77
(14) Ladder in good condition?				77
(15) Condition of the gate house?				81
(16) Emergency plan completed for the dam?				43
a. Posted in the gatehouse?				43
(17) Other?				82

D. Stilling Basin

(1) Do concrete surfaces show:				
a. Spalling?				62
b. Cracking?				82
c. Erosion?				82
d. Exposed reinforcement?				82
(2) Do joints show:				
a. Displacement or offset?				62
b. Loss of joint material?				62
c. Leakage?				62
(3) Do energy dissipators show:				
a. Signs of deterioration?				62
b. Are they covered with debris?				62
(4) Other?				63

ITEM	YES	NO	REMARKS	*ICC
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3. OUTLET WORKS (continued)

E. Downstream Channel

(1) Is the channel:				
a. Eroding or backcutting?				38
b. Sloughing?				38
c. Obstructed?				40
(2) Is released water:				
a. Undercutting the outlet?				52, 62
b. Eroding the embankment?				52, 62
(3) Other?				56, 63

4. SPILLWAY

A. Description

(1) Location?				N/A
(2) Type of Spillway?				N/A
(3) Size of Spillway?				N/A
(4) Spillway lining?				N/A
(5) Is there a weir?				61
(6) Is the spillway in good condition?				N/A
(7) Any drains?				N/A
a. Describe the condition of drains.				64

B. Does spillway show:

(1) Any cracking concrete?				57, 58
(2) Any spalling concrete?				57, 58
(3) Any exposed reinforcement in the concrete?				57, 58
(4) Any erosion?				52

ITEM	YES	NO	REMARKS	*ICC
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4. B. Does spillway show: (continued)

(5) Any slope sloughing?				51
(6) Any obstructions?				54
(7) Displacement or offset joints?				59
(8) Loss of joint material?				57, 58
(9) Leakage at the joints?				57, 58
(10) Other?				63

C. Do the energy dissipators show:

(1) Signs of deterioration?				62
(2) Any cracking?				62
(3) Any spalling?				62
(4) Any exposed reinforcement?				62
(5) Are they covered with debris?				62
(6) Other?				64

D. Has release water:

(1) Eroded the embankment?				52
(2) Undercut the outlet?				52
(3) Eroded the downstream channel?				52
(4) Other?				56

E. Emergency Spillway

(1) Is there an emergency spillway?			(If YES, describe)	55

ITEM	YES	NO	REMARKS	*ICC
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5. RESERVOIR CONTROL

(A) Recent upstream development?				47
(B) Recent downstream development?				48
(C) Slides in reservoir area?				44
(D) Change in reservoir operation?				48
(E) Large impoundment upstream?				49
(F) Any debris in the reservoir?				50
(G) Other?				50

6. INSTRUMENTATION

(A) List type(s) of instrumentation:				27-33
(B) In good condition?				27-33
(C) Read periodically?				27-33
(D) Is data available?				27-33
(E) Include all data gathered since last report.				

7. DOWNSTREAM CONDITION

A. Downstream Land Use.

	41
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This dam was inspected by:

Additional comments and recommendations. (Use additional pages)





